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OBSERVATIONS ON BROOD X OF PERIODICAL CICADAS: 1987-1990 (HOMOPTERA: CICADIDAE)

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Abstract.—Hordes of brood X of the 17-year periodical cicadas (*Magicicada* spp.) emerged on schedule in 1987 in Silver Spring, Maryland. Nymphs emerged from burrows in the ground from late April through early May, crawled up trees and other accessible objects and molted in one to several hours. Adults soon attracted attention, the males with their courting songs and both sexes with erratic flight. Females made punctures in twigs, deposited an average of 16 firm, white eggs in pockets (egg nests) in the punctures and died by 1 July. Eggs hatched in four to six weeks or collapsed, and nymphs fell to the ground to burrow in it or died in the nests. Hatched eggs did not change color or appear perceptibly different from July 1987 to November 1990; collapsed eggs and dead nymphs became brown. Between August and November 1987 many twigs broke at punctures and dropped to the ground; many others remained on the trees, continued to grow and partially or completely enclosed punctures by November 1990.

Key Words: Cicadidae, *Magicicada,* punctures, eggs, nymphs

Brood X of the periodical cicadas (*Magicicada septendecim* (L.), *M. cassini* (Fisher) and *M. septendecula* Moore and Alexander) emerged from burrows in the ground in 1987 exactly on schedule, just as they have done every 17 years since 1715 (Marlatt 1907, Dybas 1970). The thought of insects living in the ground for 17 years and then emerging at a designated time seemed improbable and remarkable to many people. The appearance of hordes of cicadas pleased entomologists and other nature lovers and alarmed horticulturists and others who anticipated severe injury to trees and shrubs from punctures made by egg-laying females. The insects themselves, the loud, recurring, mating songs of the males and erratic flights of both sexes annoyed many people. The cicadas and their behavior attracted a great deal of attention on television, radio and in the press. As in the past, they were discussed as food for birds, squirrels, other predators and humans. Fitch (1855) reported that cicadas, when roasted and well browned, were a favorite food of North American Indians. In 1987 cicada dishes were found to be of excellent quality when properly prepared.

MATERIALS AND METHODS

Our observations were made from early April 1987 through October 1990 in a wooded suburban area of 0.25 ha in Silver Spring, Montgomery County, Maryland. Egg nests, a term used by Marlatt (1907), Snodgrass (1921), Lloyd and White (1976) to denote the pocket or repository of eggs in punctures or slits made by female cicadas, were examined three to five times a week from mid-May through August 1987; thereafter they were examined three to five times a month, except from December to March, through October 1990. Well over 3500 egg

Fig. 1. Adult periodical cicada.
Fig. 2. Nymphal skin of periodical cicada.

nests were inspected. We attempted to obtain new, or confirm old information on periodical cicadas, particularly on hatched and unhatched eggs, egg nests and first-instar nymphs. As Snodgrass (1921) stated, ". . . there is still plenty to be learned from them each time they make their visit to this part of the world."

Earlier observations on brood X in Maryland were made by Snodgrass (1921), Cory and Knight (1937), Andrews (1937, 1955) and Ezzat (1957).

Results and Discussion

In early April 1987, muddy structures known as chimneys, turrets, cones, huts or other names, began to rise 2–3 cm above the earth in litter under trees. The construction of chimneys in Maryland was well documented by Cory and Knight (1937) and Andrews (1955). At first the chimneys were closed but in late April openings appeared, usually at the top. At the same time holes approximately 12–14 mm in diameter appeared in lawns and other areas away from

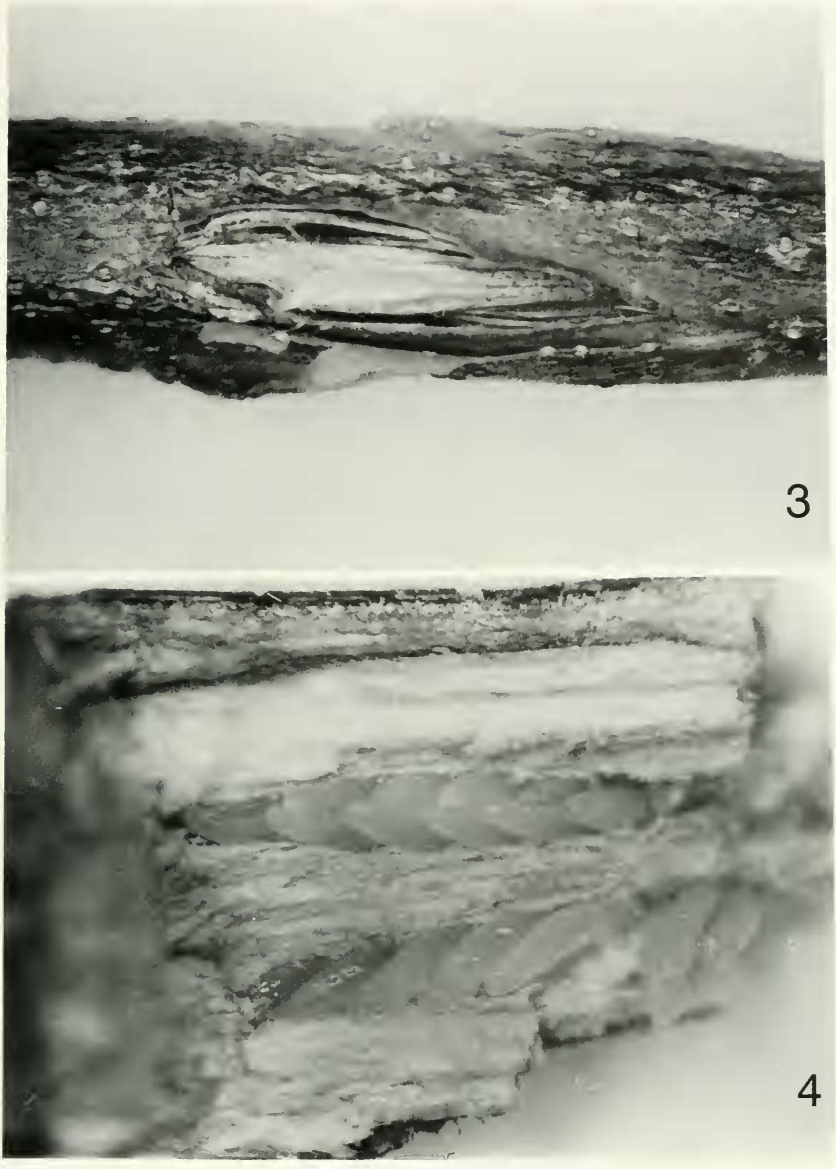

Fig. 3. Slit or puncture in twigs made by female periodical cicada.
Fig. 4. Two periodical cicada egg nests in slit.

trees and forest litter but within range of tree roots. Chimneys and holes were either almost contiguous or scattered. Just after sunset during late April and early May, nymphs, which had spent 17 years underground, emerged from chimneys and holes and crawled up trees, shrubs, posts and other accessible objects. An hour or so after nymphs attained a satisfactory position and were firmly attached, molting began, a process that required one to several hours. The cuticle split along the midline of the upper surface of the thorax and the adults (Fig. 1) emerged from the nymphal skin (Fig. 2)

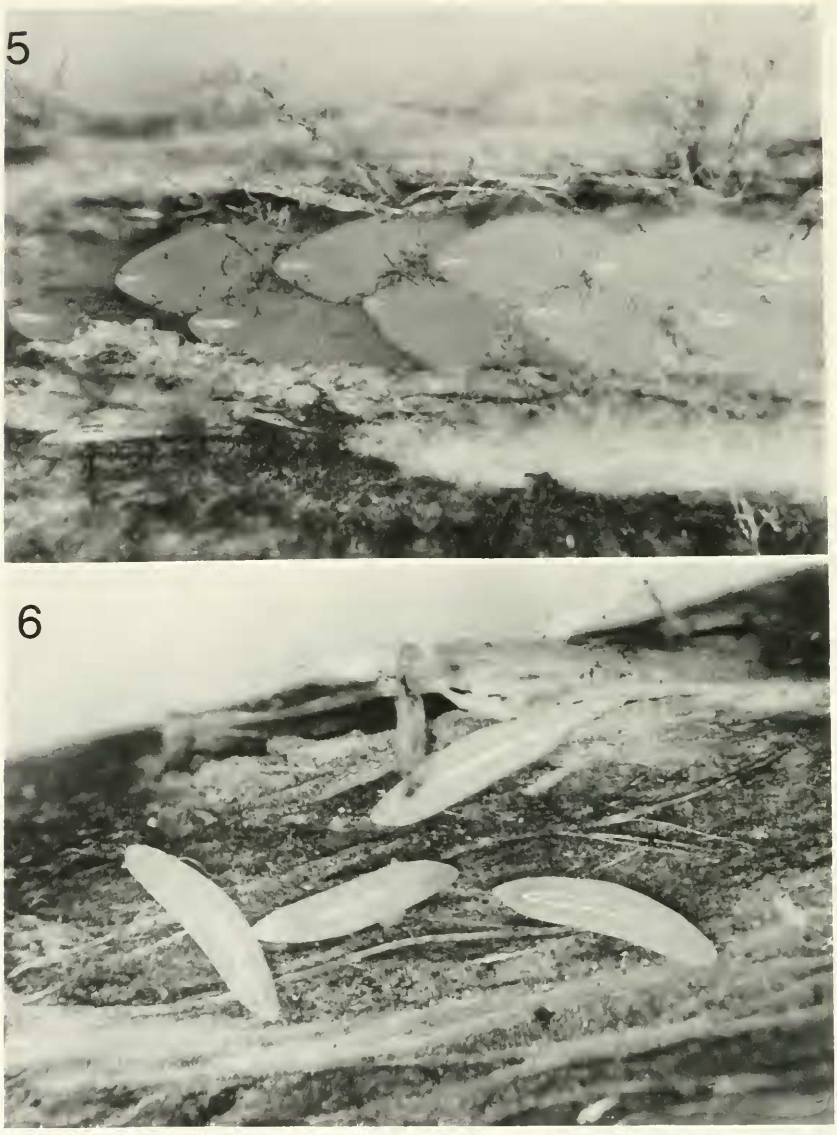

Fig. 5. One periodical cicada egg nest in slit.
Fig. 6. Eggs of periodical cicada.

some of which clung to objects over the 1987–1988 winter months.

Adults.—Upon emergence from the nymphal skins, the adults were moist and cream colored with bright red eyes; but they soon dried and darkened; and, after their wings had expanded, they started to fly. The males began their loud courting songs and soon afterward mated. Adults were first seen 10 May 1987, increased in numbers until 15 June, and then declined until 1 July when the last living ones were observed in 1987. On 28 May 1988, however, a female cicada ascended the trunk of an oak tree and on 31 May 1988 a cast nymphal skin, possibly of this female, was attached to the leaf of a nearby rhododendron. Both, presumed to be stragglers of brood X of the periodical

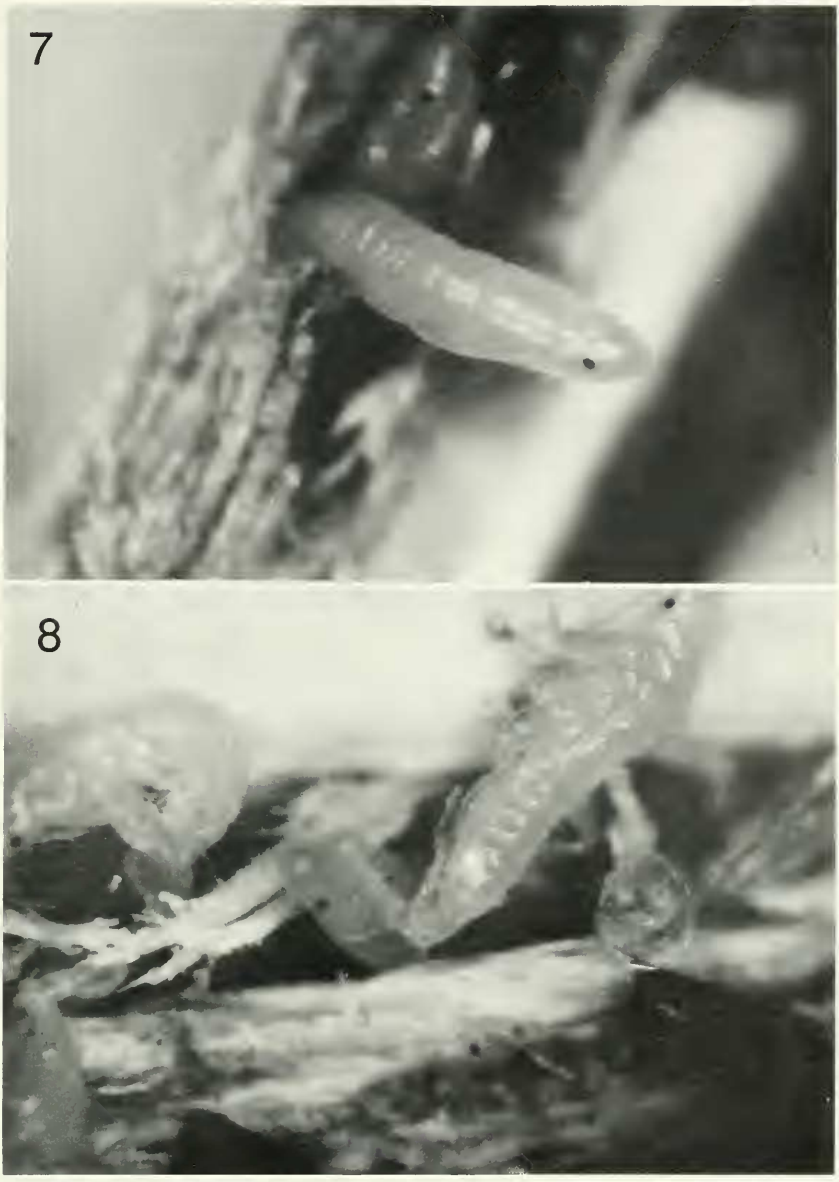

Fig. 7. Embryo of periodical cicada inside egg.
Fig. 8. Periodical cicada embryo emerging from eggs and shedding embryonic membrane.

cicadas of 1987, were the only ones seen in 1988.

Females, using their strong, toothed ovipositors, sawed punctures, or slits, in twigs 4–10 mm in diameter; most slits were in the outer wood but rarely one reached the pith. Slits (Fig. 3) 6–12 mm long usually were in the lower, but a few were in the upper surface of twigs; they were lengthwise, end to end, far apart or so close laterally that slits encircled the twigs. First observed 20 May 1987, punctures increased in number in proportion to adults, weakened twigs and caused drooping, often called flagging, and sometimes complete breakage.

Of the plants examined, punctures were

Fig. 9. Periodical cicada nymph mounted on slide.
Fig. 10. Periodical cicada nymphs in rain gutter.

most numerous in flowering crab apple (*Malus angustifolia* (Ait.) Michx.), wild cherry (*Prunus serotina* J. F. Ehrh.), American beech (*Fagus grandifolia* J. F. Ehrh.), hickory (*Carya glabra* Mill.), white, pin, and red oak (*Quercus alba* L., *Q. palustris* Muenchh., and *Q. rubra* L.); they were much less numerous in dogwood (*Cornus florida* L.), maple (*Acer* sp.), forsythia (*Forsythia suspensa* (Thunb.) Vahl), American holly (*Ilex opaca* Ait.), imported holly (*Ilex* sp.), mountain laurel (*Kalmia latifolia* L.), azalea and rhododendron (*Rhododendron* spp.) and weigela (*Weigela* sp.). Punctures were scarce in American holly trees but were fairly numerous in suckers of an imported holly. Flagging was not observed in azaleas, forsythias, hollies, mountain laurel, rhododendrons, or weigelas.

Egg nests.—Egg nests (Fig. 4) 4–10 mm long were at a slight angle to the grain of the wood. Usually there were two nests (Fig. 4) but sometimes only one (Fig. 5) in a slit. Snodgrass (1921), Ezzat (1957) and Krombein and Krombein (1971) implied that there were always two.

Eggs.—Eggs were deposited in a double row, usually of 10–26 with an average of 16, but their number varied from four, found once in maple, to 30 found once in flowering crab apple. Viable-appearing eggs were present in most plants 20 May to 5 August but were observed, in mountain laurel only, 20 August. By 24 July most, and by 5 August virtually all, eggs had hatched or collapsed in flagged and unflagged twigs. The incubation period of eggs was not determined exactly, but it ranged from at least four, to six weeks.

Viable eggs (Fig. 6) were white and firm and could be rolled on a glass surface or brushed by hand without apparent injury. They were approximately 2 mm long and 0.5 mm in diameter, a slight variation in size may have indicated that they were laid by more than one species of 17-year periodical cicadas (*M. septendecim, M. cassini* or *M. septendecula*) or that some were enlarged by the absorption of water. Marlatt (1907) stated that cicada eggs ". . . receive a certain nourishment from the plant and actually increase in size before hatching, by absorption of the juices from adjacent plant cells." White and Lloyd (1981) indicated that water was absorbed by cicada eggs and that they increased in size, but stated further ". . . there is no direct evidence for the absorption of nutrients in addition to water."

Hatched eggs retained their original color during our entire study. Thousands of eggs did not hatch, however, and they became pale brown over the winter and spring of 1987–1988; by August 1988 they were dark brown and desiccated but they had not disintegrated; they remained in this condition through October 1990. Collapsed eggs did not exhibit shades of yellow or red as did those observed by White and Lloyd (1981).

Embryos and first-instar nymphs.—Red eye spots appeared within eggs a week or two before they hatched, and embryos (Fig. 7) became visible two to three hours before the egg shells started to break; the embryos wiggled forward out of the shells in one to two minutes and shed an enclosing (amniotic) membrane (Fig. 8) as they emerged. Nymphs (Fig. 9) that escaped from the nests were white with red eyes and reddish forelegs that were greatly enlarged and modified for burrowing in the soil, an activity well documented by Snodgrass (1921) and Andrews (1937). Many nymphs died in the egg nests and their color was similar to that of collapsed eggs, changing from light to dark brown and becoming desiccated but not disintegrated by October 1990.

Astonishing numbers of first-instar nymphs and adults were present in rain gutters on a house overhung by beech and oak trees. By 26 June 1987 the gutters resembled a cicada mortuary with numerous dead and decaying adults and nymphs emitting an offensive odor. By 14 July the gutters contained such a quantity of living and dead first-instar nymphs (Fig. 10) that they could be taken up in large spoonfuls. The living

nymphs moved so rapidly that it was difficult to seize them with forceps.

Regarding periodical cicadas, Marlatt (1907) stated, ". . . the young ant like larva, hatching from the egg a few weeks after the latter has been laid, escapes from the wounded limb, falls lightly to the ground, and quickly burrows out of sight . . ."

One objective of our investigation was to determine whether eggs hatched after, as well as before, twigs dropped to the ground. We assumed that if eggs reached the point of eclosion, they could hatch in fallen twigs, particularly in those that had remained on the trees for a longer time. We did not find hatching eggs in fallen twigs, but in the laboratory, eggs hatched in twigs that had been cut from trees and shrubs. Thus it appeared that, if the eggs were viable and had completed the incubation period, they would hatch in twigs on the ground. Because comparatively few twigs fell from punctured areas before August or September 1987, incubation of the eggs would have been complete and hatching would have occurred on the trees. This observation and the enormous numbers of nymphs found in the rain gutters were evidence that virtually all eggs that hatched did so while twigs were on the trees.

Damage.—Trees and shrubs had grown well beyond punctures made in 1987 by the summer of 1989, and in late June numerous twigs fell to the ground during two severe storms when winds attained 70–90 miles per hour. Examination of hundreds of twigs revealed that more oak twigs broke at nodes than at punctures while more beech and wild cherry twigs broke at punctures. Azalea, forsythia, hollies, mountain laurel, rhododendron and weigela, which had not flagged in 1987, did not break during the June 1989 storms. By October 1990 new growth extended 30–90 cm beyond the cicada punctures of 1987 and few twigs that dropped to the ground broke at punctures.

Healing.—The extent and rate of plant growth around punctures varied greatly from 1987 to 1990. In azalea and forsythia, wounds were healed by summer 1988 when most punctures in oaks, wild cherry and beech were only partially closed. Healing in the latter plants varied also, possibly depending on the size of twigs as was suggested by Lloyd and White (1976). In 1988, a conspicuous brush of wood fibers usually extended along the punctures and cicada egg shells often could be detected in the egg nests. By October 1990, most punctures in oaks, rhododendrons and weigelas remained well-defined; and occasionally cicada egg shells could be seen in egg nests. In beech, wild cherry and dogwood, however, most punctures were entirely closed and none, or a few very short wood fibers remained. Regardless of the extent of healing, visible scars remained after 42 months.

Acknowledgments

We dedicate this article to the memory of the life and research accomplishments of our friend and colleague, Donald R. Whitehead.

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